

WHAT IS CLAIMED IS:

1. A free-cutting tool steel containing Fe as a major component and C in an amount of 0.1 to 2.5 wt%;

5 containing Ti and/or Zr so that $W_{Ti} + 0.52W_{Zr}$ amounts to 0.03 to 3.5 wt%, where W_{Ti} represents Ti content (wt%) and W_{Zr} represents Zr content (wt%);

sb
a.1
10 containing at least any one of S, Se and Te so that $W_s + 0.4W_{Se} + 0.25W_{Te}$ amounts to 0.01 to 1.0 wt%, and so that $(W_{Ti} + 0.52W_{Zr}) / (W_s + 0.4W_{Se} + 0.25W_{Te})$ amounts to 1 to 4, where W_s represents S content (wt%), W_{Se} represents Se content (wt%) and W_{Te} represents Te content (wt%); and

15 having dispersed in a texture thereof a machinability improving compound phase within a range from 0.1 to 10% in terms of area ratio in a section;

said machinability improving compound phase comprising a metallic element component having Ti and/or Zr as major components, and a binding component for such metallic element component essentially containing C and also
20 containing any one of S, Se and Te.

2. The free-cutting tool steel according to Claim 1, wherein said machinability improving compound phase mainly comprises a component phase expressed by a composition
25 formula $M_4Q_2C_2$ (where M represents the metallic element component mainly comprises Ti and/or Zr, and Q represents at least any one of S, Se and Te).

3. The free-cutting tool steel according to Claim 1 further containing any one element selected from Mn in an amount of 2.0 wt% or less, Ni in an amount of 2.5 wt% or less, Cr in an amount of 17 wt% or less, Mo and/or W so that
5 Mo + 0.5W amounts to 12 wt% or less, V in an amount of 6 wt% or less, and Co in an amount of 15 wt% or less.

4. The free-cutting tool steel according to Claim 1 wherein Si amount is 2.0 wt% or less, Al amount is 0.1 wt%
10 or less and N amount is 0.040 wt% or less.

5. The free-cutting tool steel according to Claim 1 further containing any one element selected from Ca in an amount of 0.0050 wt% or less, Pb in an amount of 0.2 wt% or
15 less, Bi in an amount of 0.2 wt% or less, Nb and/or Ta so that Nb + 0.5Ta amounts to 0.05 wt% or less, and a rare earth metal in an amount of 0.50 wt%.

6. The free-cutting tool steel according to Claim 1
20 containing C in an amount of 0.1 to 0.6 wt%; and

containing at least any one element selected from Mn in an amount of 2.0 wt% or less, Ni in an amount of 1.0 wt% or less, Cr in an amount of 3 wt% or less, Mo and/or W so that Mo + 0.5W amounts to 1.0 wt% or less, V in an amount of
25 0.5 wt% or less, and Co in an amount of 1.0 wt% or less.

7. The free-cutting tool steel according to Claim 6 used as a source material for die for molding plastics.

1008495-022802

8. The free-cutting tool steel according to Claim 1 containing C in an amount of 0.2 to 0.6 wt%;

essentially containing Cr in an amount of 0.3 to 7
5 wt%; and

containing at least any one element selected from Mn in an amount of 2.0 wt% or less, Ni in an amount of 2.5 wt% or less, Mo and/or W so that $Mo + 0.5W$ amounts to 4.0 wt% or less, V in an amount of 2 wt% or less, and Co in an amount
10 of 5.0 wt% or less.

9. The free-cutting tool steel according to Claim 8 used as a source material for hot forming die.

15 10. The free-cutting tool steel according to Claim 1 containing C in an amount of 0.3 to 1.8 wt%; and

containing at least any one element selected from Cr in an amount of 4 wt% or less, Mn in an amount of 2.0 wt% or less, Ni in an amount of 2.5 wt% or less, Mo and/or W so
20 that $Mo + 0.5W$ amounts to 2.5 wt% or less, V in an amount of 1 wt% or less, and Co in an amount of 1.0 wt% or less.

11. The free-cutting tool steel according to Claim 10 used as a source material for cold forming die, cutting
25 tool or impact-resistant tool.

12. The free-cutting tool steel according to Claim 1 containing C in an amount of 0.5 to 2.5 wt%;

10084495-022802

essentially containing Cr in an amount of 4 to 17 wt%;
and

containing at least any one element selected from Mn
in an amount of 2.0 wt% or less, Ni in an amount of 1.0 wt%
5 or less, Mo and/or W so that $Mo + 0.5W$ amounts to 1.5 wt% or
less, V in an amount of 1 wt% or less, and Co in an amount
of 1.0 wt% or less.

13. The free-cutting tool steel according to Claim
10 12 used as a source material for cold forming die.

14. The free-cutting tool steel according to Claim 1
containing C in an amount of 0.5 to 2.0 wt%;

containing at least any three elements selected from
15 Cr as an essential element in an amount of 3 to 7 wt%, Mo
and/or W as an essential element so that $Mo + 0.5W$ amounts
to 4 to 12 wt%, V as an essential element in an amount of
0.5 to 6.0 wt%, Mn in an amount of 2.0 wt% or less, Ni in an
amount of 1.0 wt% or less, and Co in an amount of 15.0 wt%
20 or less.

15. The free-cutting tool steel according to Claim
14 used as a source material for cutting tool, cold forming
die or hot forming die.

25 16. A free-cutting tool steel containing Fe as a
major component and C in an amount of 0.001 to 0.6 wt%; and
further containing Ni in an amount of 6 wt% or less,

200220" 56448001

Cu in an amount of 5 wt% or less and Al in an amount of 3 wt% or less;

wherein such tool steel further contains:

5 Ti and/or Zr so that $X \text{ (wt\%)} = W_{Ti} + 0.52W_{Zr}$ amounts to 0.03 to 3.5 wt%, where W_{Ti} represents Ti content (wt%) and W_{Zr} represents Zr content (wt%);

10 at least any one of S, Se and Te so that $Y \text{ (wt\%)} = W_S + 0.4W_{Se} + 0.25W_{Te}$ amounts to 0.01 to 1 wt%, where W_S represents S content (wt%), W_{Se} represents Se content (wt%) and W_{Te} represents Te content (wt%); and

having dispersed in a texture thereof a machinability improving compound phase;

15 said machinability improving compound phase comprising a metallic element component having Ti and/or Zr as major components, and a binding component for such metallic element component essentially containing C and also containing any one of S, Se and Te.

20 17. The free-cutting tool steel according to Claim 16, wherein the values X and Y are defined so as to satisfy a relation of $1 \leq X/Y \leq 4$.

25 18. The free-cutting tool steel according to Claim 16, wherein said machinability improving compound phase mainly comprises a component phase expressed by a composition formula $M_4Q_2C_2$ (where M represents the metallic element component mainly comprises Ti and/or Zr, and Q represents any one of S, Se and Te).

10084495-022802

19. The free-cutting tool steel according to Claim 16 having a ratio of Charpy impact values I_T/I_L of 0.3 or above, where

5 I_T is a Charpy impact value of a T-directional test piece and I_L is a Charpy impact value of an L-directional test piece:

said impact values being obtained in Charpy impact test specified by JIS Z2242; and

10 said T-directional test piece and L-directional test piece being fabricated as No. 3 test pieces specified in JIS Z2202 by notching a forged-and-rolled product of such tool steel along the directions parallel to and normal to the forging-and-rolling direction, respectively.

15 20. The free-cutting tool steel according to Claim 16, wherein said machinability improving compound phase observed in a polished surface of such tool steel has an area ratio of 0.1 to 10%.

20 21. The free-cutting tool steel according to Claim 16 satisfying relations of

$$0.2X \leq Y \leq X; \text{ and}$$

$$0.07X \leq W_c \leq 0.75X$$

25 where W_c represents C content (wt%).

22. The free-cutting tool steel according to Claim 16 containing Cr in an amount of 22 wt% or less; and

10084495 022302

containing at least any one element selected from Mo and/or W so that $W_{Mo} + 0.5W_W$ amounts to 4 wt% or less, where W_{Mo} represents Mo content (wt%) and W_W represents W content (wt%), Mn in an amount of 3 wt% or less, Co in an amount of 2 wt% or less, Nb in an amount of 1 wt% or less and V in an amount of 1 wt%.

23. The free-cutting tool steel according to Claim 16 wherein Si amount is 2 wt% or less, N amount is 0.04 wt% or less, and O amount is 0.03 wt% or less.

24. The free-cutting tool steel according to Claim 16 further containing Ca in an amount of 0.005 wt% or less, Pb in an amount of 0.2 wt% or less, Bi in an amount of 0.2 wt% or less, Ta in an amount of 0.05 wt% or less, B in an amount of 0.01 wt% or less, and a rare earth metal element in an amount of 0.5 wt% or less.

25. The free-cutting tool steel according to Claim 16 containing C in an amount of 0.001 to 0.4 wt%, Cu in an amount of 0.5 to 5 wt%, Ni in an amount of 1 to 5 wt%, and Al in an amount of 0.5 to 3 wt%; and wherein Cr amount is 10 wt% or less.

26. The free-cutting tool steel according to Claim 16 containing Cr in an amount of 10 to 22 wt%.

27. The free-cutting tool steel according to Claim

10084495-022802

16 used as a source material for die for molding plastics.

10084495 022802